DEFESA DE DISSERTAÇÃO DE MESTRADO Nº 100

Mestrado em Engenharia de Computação

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Título: **Weight-Based Approach for Niching in Fish School Search**

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Abstract:

Optimization tasks are present in many situations where information technology is required. Formally, to optimize can be understood as a system adjustment aiming to obtain the best possible output. Among many perspectives, optimization problems can be classified as unimodal or multimodal. Contrary to unimodal ones, multimodal problems are characterized by the existence of more than one optimal solution.

Several nature-inspired methods have been developed in order to tackle the multitude of available solutions of Multimodal problems. A successful set of such techniques is known as population based algorithms (PBA), due to their characteristics of searching using a group of artificial entities, collectively and in a coordinated manner. Within the PBA set, niching algorithms are techniques that searches for multiple optima in multimodal functions.

Swarm Intelligence (SI) can be seen as a property of systems in which the interaction between very simple components generates complex functional patterns. Within Computational Intelligence field, many PBAs present such behavior. These algorithms form the so-called Swarm Intelligence approach.

Fish School Search (FSS), a successful optimization family of algorithms, part of the Swarm Intelligence, was introduced and still addresses today, mostly unimodal problems. It is inspired on the collective behavior of fish schools. The mechanisms of feeding and coordinated movements were used as means to create the collective search mechanism of the algorithm. This work investigates how the important weights of fish in FSS can be used to automatically split fish schools in order to find multiple optima in multimodal functions (i.e. this using almost only local information). The main changes made in the original FSS were: creation of a linking rule, which defines leaders for each fish, using solely the weight of the fishes as the main criterion, and addition of a multiplying factor that regulates the influence of the collective movement operators in the final displacement of the fishes. Such changes resulted in a new niching version of the FSS algorithm: Weight based Fish School Search (wFSS).

The comprehensive sets of experiments carried out evaluated the wFSS performance against five other algorithms: Density based Fish School Search (dFSS) – which is the only existing multimodal version of FSS, R2PSO, R3PSO, R2PSO_LHC and R3PSO_LHC, which are four PSO-based, state-of-the-art, niching algorithms. Eight well-known continuous functions (with 2, 3, 5 and 10 dimensions) were used for benchmark purposes with four distinct metrics.

The results showed that the wFSS easily overcame the dFSS algorithm for all metrics used in the experiments in all functions with all number of dimensions used. Not less importantly, wFSS computational complexity is $T(n) \in O(n^2)$ against $T(n) \in O(n^4)$ for dFSS. Moreover, differently from the dFSS, no niching parameters were added to the original FSS in order to create the wFSS. Regarding the comparisons made with the four aforementioned PSO-based algorithms, wFSS clearly overcame R2PSO_LHC, R3PSO_LHC and R2PSO. Only in some exceptional cases (few metrics/functions), wFSS algorithm could not outperform R3PSO. Therefore, wFSS can now unarguably be considered the best multimodal technique among all compared algorithms.